

# **COMMUNITY BASED RISK ASSESSMENT ON LANDSLIDES IN SIDDHALEKH-DHADING**

**By**

**Ashmita Thapa Magar**

**ID 20268019**

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Postgraduate Programs in Disaster Management (PPDM)

Department of Architecture

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**DECLARATION**

It is hereby declared that:

1. The thesis submitted is my own original work while completing a degree at Brac University.
2. The thesis does not include any content published before or written by a third party, unless it is properly cited with complete and correct referencing.
3. The thesis does not include any content that has been approved or submitted for consideration for any other degree or certificate at a university or other institution.
4. I have given credit to all major sources of assistance.



Ashmita Thapa Magar  
20268019

## APPROVAL

The thesis/project titled “COMMUNITY BASED RISK ASSESSMENT ON LANDSLIDES IN SIDDHALEKH-DHADING” submitted by Ashmita Thapa Magar (20268019) of Fall 2020 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master of Disaster Management on February 10 2024.


### Examining Committee:

Supervisor:  
(Member)



Mohammad Faruk, PhD  
Associate Professor  
Department of Architecture  
Brac University

Program Coordinator:  
(Member)



Muhammad Ferdaus  
Lecturer & Coordinator  
Postgraduate Programs in Disaster Management (PPDM)  
Brac University

External Examiner:  
(Member)



Md. Mizanur Rahman, PhD  
Professor  
Department of Geography and Environment,  
Jahangirnagar University

Departmental Head:  
(Chair)



Zainab Faruqui Ali, PhD  
Chairperson, Postgraduate Programs in Disaster Management Board  
Chairperson and Professor, Department of Architecture  
Brac University

## **ETHICAL STATEMENT**

The investigation was carried out with ethical competence and integrity, considering ethical standards, social, economic, and ecological outcomes, when making decisions and acting responsibly. Prior to beginning the field survey, permission was requested from each authority to survey the research regions. All actions, including taking pictures and speaking with the respondents, were done with approval from the relevant authority.

One of the main ethical guidelines followed in this study is to preserve participant participation in the data collection process and analysis in order to protect their rights to access information and their freedom of expression. There was no action included in the study that might have been expected to put participants at risk or cause them any discomfort. Similarly, the participants' oral consent was obtained before conducting the interviews, focus groups, and questionnaire surveys. Each respondent in the study was given a unique identifying number used throughout the data processing and findings. Every time any form of intellectual property is used in this work, correct citation and credit are provided.

## ABSTRACT

Landslide is one of the most recurring and damage inducing disaster around the world as well as in Nepal. Despite being a recurring disaster in Siddhalekh Rural Municipality, one of the remote areas of Nepal, the events and consequences have not made it to the official records as human deaths are absent. However, the local community has to face various troubles as a result of landslides. This research aims to understand the community perceptions, livelihood options and assess the vulnerability of the people that is resulted by landslides in the region through a process of Community based risk assessment (CRA). The study was carried out within Siddhalekh rural municipality, where primary information was collected from various field visits in the form of transect walks. The data collection for the study was done through focus group discussion (FGD), semi-structured interview/key informants' interview and literature review of secondary data. A total of 80 students participated in the questionnaire survey, 10 discussion groups and 35 key informants were interviewed. The qualitative data were extracted through content analysis and methodological triangulation and cross checked to test the validity through the convergence of information from these research tools.

The results of the study revealed that the community people of the region are at risk of landslides. Heavy rainfall, steep slopes, excavation of hills to develop roads were found to be the major triggering factors of landslides. Roadside landslides were found to be most common as the construction of the newly built roads were not finished properly and hills remained excavated letting loose soil flow. Due to landslides, the local community suffered disturbances in their daily lives and economic activities were altered. Despite having knowledge about the risk of landslides, locals were tempted to settle near the roads for better opportunity which increased their vulnerability even more. The ultimate solution was found to be proper policy planning regarding the risk reduction and budget allocation for afforestation, appropriate afforestation, proper management of bare slopes after cutting for road expansions and various campaigns to create awareness among people. If proper assessment is done, the community will benefit from development activities and the vulnerability from landslide risk will decrease.

***Keywords: Community participation, risk assessment, landslides, road expansions.***

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## LIST OF ACRONYMS AND ABBREVIATIONS

%	Percentage
&	And
ADRC	Asian Disaster Reduction Center
APRR	Action Plan for Risk Reduction
CBDRM	Community Based Disaster Risk management
CRA	Community Risk Assessment
DoR	Department of Roads
DRR	Disaster Risk Reduction
et al.	and others (from Latin et alii)
etc.	and so forth (from Latin et cetera)
FGD	Focused Group Discussion
GoN	Government of Nepal
NDRR	National disaster risk reduction
NGO	Non-Governmental Organization
NOEC	National Emergency Operation Centre
NSDRM	National Strategy for Disaster Risk Management
SMS	Short Message Service
TV	Television
UNDRR	United Nations Office for Disaster Risk Reduction
USD	United States Dollar
VDC	Village Development Committee

## OPERATIONAL DEFINITION TERMS

<b>Early warning</b>	advance notice of an impending event
<b>Erosion</b>	wearing away of the upper layer of soil
<b>Exposure</b>	state of being exposed to contact with something
<b>Hazard</b>	a danger
<b>Landslide</b>	sliding down of a mass of earth or rock from a hill
<b>Mitigation</b>	act of reducing severity of something
<b>Participation</b>	the action of taking part in something
<b>Prevention</b>	an action of stopping something from happening
<b>Resilience</b>	an ability to recover from
<b>Risk</b>	Possibility of loss or injury
<b>Susceptibility</b>	the state of being liable to be influenced or harmed by something
<b>Vulnerability</b>	the state of being exposed to the possibility of being harmed either physically or emotionally
<b>Water- logging</b>	saturation of soil with water

## **CHAPTER ONE**

### **PROBLEM STATEMENT**

#### **1.1 INTRODUCTION**

The mountainous, landlocked nation of Nepal lies on the geological division between the Indian and Himalayan plates. Landslides therefore create significant hurdle in development in Nepal, as they annually result in significant economic loss and fatalities. There is a common belief that landslide impacts in nations like Nepal are getting worse with time, but up until now, there hasn't been much, if any, quantitative data to back this up or to explain the reasons for the increases. Landslide is a geological hazard which comprises a wide range of ground movements and happens in the hilly part (Chisty, 2014).

Little trails connect several communities in the Middle Hills region of rural Nepal, limiting access to social and economic opportunities. When the community feels ignored by respective authority, they tend to take action in their hands. Communities turn these pathways which are partly sponsored by remittances sent from abroad into motorized roadways as the country develops to improve access to marketplaces, educational opportunities, and healthcare. In the absence of professionals' supervision, the undercutting of slopes may lead to allowing water to infiltrate into hazardous slide planes, and producing debris that is easily mobilized following heavy rainfall, the ensuing informal roadways frequently cause landslides. Also, in the terrains that have loose soil type and the access to heavy equipment speeds up road building, and the landslides that are triggered as a result disrupt transportation networks that transport daily needed goods and services to and from rural communities. They also harm agricultural lands in areas where subsistence farming is the norm, and might result in several fatalities each year. These phenomena continue every year and people suffer in the contrary to their hopes and beliefs of developmental gain.

A violent cloudburst that occurred on July 29 and 30, 2015, during the first monsoon season following the 7.8 Richter scale Gorkha earthquake, caused landslides that claimed the lives of 29 people in Nepal's western region. These tragic landslides and numerous others like them are not just the result of increased rainfall brought on by climate change, but also the result of a complex interplay between socioeconomic factors and a greatly altered physical landscape where unmaintained, un-engineered roads frequently collapse during the annual monsoon season. This issue will worsen as China's Belt and Road Initiative (BRI) seeks to increase trade with Nepal, India, and other countries through a network of trans-Himalayan corridors that pass across some of the world's most difficult geological terrain. With a hope to get a better standard and easier

trades for living, the people will attempt to connect their settlements to these highways with improvised roads built and maintained with extremely limited resources, putting them in higher risk of landslides. This increased transportation network will have unforeseen repercussions on the surrounding ecosystems if they remain unsupervised and untamed as they have been since a long time (McAdoo et al., 2018).

Road issues and related landslides have persisted since a long time but are little-researched phenomena. In an early analysis conducted by Laban on how human development affects the distribution of landslides in Nepal, he came to the conclusion that only 5% of recorded landslides were connected to roads during the early stages of the country's development of motorized roadways. However, it was seen to have more than quadrupled from 13.7 km<sup>2</sup> in 1998 to 49.6 km<sup>2</sup> in 2016 (DoR, 2023). Petley and his team revealed that the frequency of landslide fatalities in Nepal substantially rose between 1978 and 2005 and which reasonably raised concern over poorly built roads in Nepal (Petley et al., 2007).

Dhading is a district situated in Bagmati province in Nepal which has high susceptibility to landslides due to its hilly terrain. The rural municipalities that are at much higher altitude are prone to landslides. Numerous areas in Nepal face landslides every year during the monsoon season. Steep hill slopes, river gradient and high tectonic activities have been the major cause for occurrence of landslides (Pyakurel, 2014). Annual damage of almost a billion USD is caused by the landslides along with human casualties. The major landslides are reported in the media and kept in records. However, many landslides that take place in the district go unreported after they occur. Despite the occurrence, those small-scale landslides are not taken seriously and may take lives if not assessed and informed on time. Even if there are no recorded landslides of low intensity, the damages caused to the productive land can be a huge factor in altering the economic balance of such areas where agriculture is the main income source (Dahal, 2012).

The landslides that occur in highways have claimed hundreds of lives till now. A total of 1605 landslides have been recorded in the past century (Pyakurel, 2014). The landslide that took place in Prithvi highway Benighat killed 2 people, leaving 6 injured according to onlinekhabar (2021). Another news report by The Kathmandu Post (2016) listed 25 families at high risk of landslides induced post-earthquake. 7 houses were swept away and 5 people were killed in Netrawati and Khaniyabas rural municipality (Relief Web, 2018). Monsoon rains followed by seismic movements have been major reasons for reshaping and activating new landslides after the 2015

earthquake (Zambanani, 2018). Landslides not just take lives and destroy infrastructure, it also can directly affect the livelihood of people by contaminating the water bodies (Mishra, 2018) and it can lead to disease outbreaks as the people in village areas rely on rivers for consumption of water.

Although landslides have occurred in different time intervals, they might not have been recorded as they might not have taken lives of people. However, the neighboring rural municipalities of Khaniyabas, Benighat have been reported in the media as having taken the lives of several people. Salang lies in one of the remote hilly areas of Dhading and landslides are more susceptible in the villages as the construction of roads has started to take off rapidly. Every year, monsoon rain is the major cause of landslides followed by sloped terrains and soft rock beds in the area. As the hills are being transformed into road tracks the unmanaged and not completed roads are hampered by the monsoon rain and blocked after landslides. Preventive measures need to be carried out by analyzing the history of landslides in the area so that suspected injuries and damages can be mitigated as much as possible. As much as development work is required, the safety and security of people and the environment must be protected.

## **1.2 RATIONALE OF RESEARCH**

This research aims to understand the community perceptions, livelihood options and assess the vulnerability that is resulted by landslides in the region. This research will look into depth on how human activities such as construction and development of roads can be triggering factors for landslides to occur besides the monsoon rainfall by following community-based risk assessment. This research will help unfold the understanding and perception of community people of Siddhalekh who are at risk of landslides. This research will gather information on the past events of landslides in Siddhalekh, the study area, which will help discover and analyze the relationship between man-made factors of landslide, if any and its effects. Despite having several landslides in the area, they seemed to not be recorded as no human casualties took place. However, there are always chances of mishaps to occur that may claim lives, hence early assessment can be a suitable preventive measure for rural areas like Siddhalekh where emergency response can take time due to their remoteness and limited facilities.

### **1.3 RESEARCH PROBLEM**

The need to assess risk while development is going on is inevitable. However, it seems to have been going the other way. Communities like Siddhalekh who are taking baby steps towards development ought to get proper guidance or else, haphazard are likely to take place. The monsoon season is one of the risky times of the year as it is not only capable of nurturing the crops but also destroying them. Rainfall is the major reason for disasters like landslides, floods, and erosions to occur whose intensity also is affected by the amount of rainfall. In Siddhalekh rural municipality mudslides and erosion are very common followed by landslides which are triggered by rainfall along with other reasons. Besides geography, earthquakes have played an important role in the occurrence and intensity of landslides. Therefore, it is important to assess underlying hazards that could lead to changes in potential risks if a disaster takes place.

### **1.4 RESEARCH OBJECTIVES**

1. To identify and assess the risk factors that make community people vulnerable to landslides.
2. To gather information on past events of landslides and livelihood choices of community people to cope with it.
3. To compile and synthesize the information into a detailed risk assessment report, which, later may be used by the community as well as external stakeholders in future planning of the community by incorporating the information from the research.

The above-mentioned objectives will be met with the help of following research questions:

### **1.5 RESEARCH QUESTIONS**

1. How are community people vulnerable to landslides in the study area?
2. How have local communities of Siddhalekh Rural Municipality coped with events of landslides?
3. How can landslides assessment help in risk reduction in the study area?

### **1.6 RESEARCH AIM AND SIGNIFICANCE OF STUDY**

This research aims to understand the community perceptions, livelihood options and assess the vulnerability that is resulted by landslides in the region. Development of roads has been a major triggering factor for landslides to occur besides the monsoon rainfall. This research will look into depth at how mentioned factors have been a risk and will try to assess to find mitigative ways to reduce damage.



People living in hilly region of Nepal, here Siddhalekh, have faced frequent landslides of varied intensity to which they lose their properties, and at times even lives. Sometimes the landslide events are not of high intensity but strong enough to hinder daily life, they just carry on with their lives by helping each other. Due to its remoteness and lesser exposure to media, very little research was found when trying to find references to conduct this research. The lack of coverage in the media and news of events not reaching respected authorities on time has amplified the sufferings of community people in village areas. Despite having an early warning system in the country, they don't seem to be implemented well. In addition to lesser risk reduction policies and lack of awareness among the community people and the ignorant mentality has emulsified the risk caused by landslides. Hence, the major significance carried by the study is that it can help create awareness among the people, collect information on the events of landslides and be a contributory source for future risk assessments.

## CHAPTER TWO LITERATURE REVIEW

### CONCEPTUAL FRAMEWORK

#### 2.1 INTRODUCTION

This chapter will overview and analyze the research works carried out before which will be taken as reference for the research followed by risk profile and landslide hazards in Nepal which will give an overview to conceptual framework of the research. Also, it will describe landslide risk management and discuss the roles of different stakeholders.

#### 2.2 TERMINOLOGIES USED IN THE RESEARCH

**Disaster:** According to UNDRR (2023), ‘A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.’ With this definition one can know how much of a damage a disaster can do to stop or end a human life. Hence, it is necessary to take precautions and preventive measures to reduce the risk.

**Hazard:** A hazard can turn into disaster if proper precautions are not taken. UNDRR defines hazards as a process, phenomenon or human activity that is capable of causing loss of life or injury as well as other health consequences and damage to property, social and economic disturbance or environmental degradation (UNDRR, 2017). Hazards can be either natural or anthropogenic and at times socio natural and they may be single, sequential or combined according to their origin and effects.

**Risk:** While a hazard is something that will cause harm, risk is the possibility that a hazard will cause harm. In other words, hazards are natural occurrences that cannot be avoided but risk is something that is evolved from hazards and needs to be prevented. For example, a ladder can be a hazard and falling down can be a risk. Therefore, to investigate, eliminate or reduce the risk, a risk assessment is necessary. UNDRR (2017) defines risk as “The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity”.

**Vulnerability:** Generally, vulnerability is a state of being exposed to the possibility of being harmed either physically or emotionally. Putting it into technical disaster terms, UNDRR (2017) defines vulnerability as the circumstances created by physical, social, economic, and

environmental elements or processes that make people, communities, assets, or systems more vulnerable to the effects of hazards. An assessment is necessary to help people cope with hazards and increase their ability to cope, also known as coping capacity.

**Risk Assessment:** Risk assessment is a process where identification and analysis of potential adversity on individuals, assets and environment, their likelihood and ways to tackle them. Assessment of risk can have quantitative and qualitative results depending on how it must be done. With a proper risk assessment, an individual, a community and a whole nation can mitigate the possible risk caused by disasters. Sendai Framework Terminology on Disaster Risk Reduction defines Risk Assessment as, “A qualitative or quantitative approach to determine the nature and extent of disaster risk by analyzing potential hazards and evaluating existing conditions of exposure and vulnerability that together could harm people, property, services, livelihoods and the environment on which they depend” (UNDRR, 2017).

**Mitigation:** In simple words mitigation is the process of reducing the risk of loss caused by any mishap. In disaster management, it means measures taken to reduce the loss of life, livelihood and property by preventing, preparing, responding and monitoring the impact of disasters. When the impacts of hazards cannot be fully prevented, their intensity can be decreased considerably by carrying out various strategies and actions which may include engineering techniques and hazard-resistant construction (UNDRR, 2017).

### **2.3 DISASTER RISK PROFILE OF NEPAL**

The tools that assist leaders and disaster risk practitioners to make informed decisions to manage disaster risk are called Disaster Risk Profiles. The profiles consider many possible scenarios, their likelihood, and associated impacts. They provide visual information and data on hazards, exposure, and risk for multiple hazards in each country. In the present times there are several country wise Disaster Risk Profiles made as mentioned by World Bank (2021).

In the context of Nepal, the country is prone to several natural disasters due to its complicated geophysical structure or topography. Nepal is distinguished by its mountainous terrain, varying climate conditions, complicated geological structure, and continued seismic activity, since it also has an active tectonic process. The lowest point in the country is at an elevation of 70 meters, and the highest point is at 8848 meters. Due to its fragile and steep topography, it faces various natural hazards with varied intensities such as floods, landslides, earthquake, drought, glacier lake outburst flood (GLOF), and avalanches. Hence, it ranks as one of the most disaster-prone countries in the

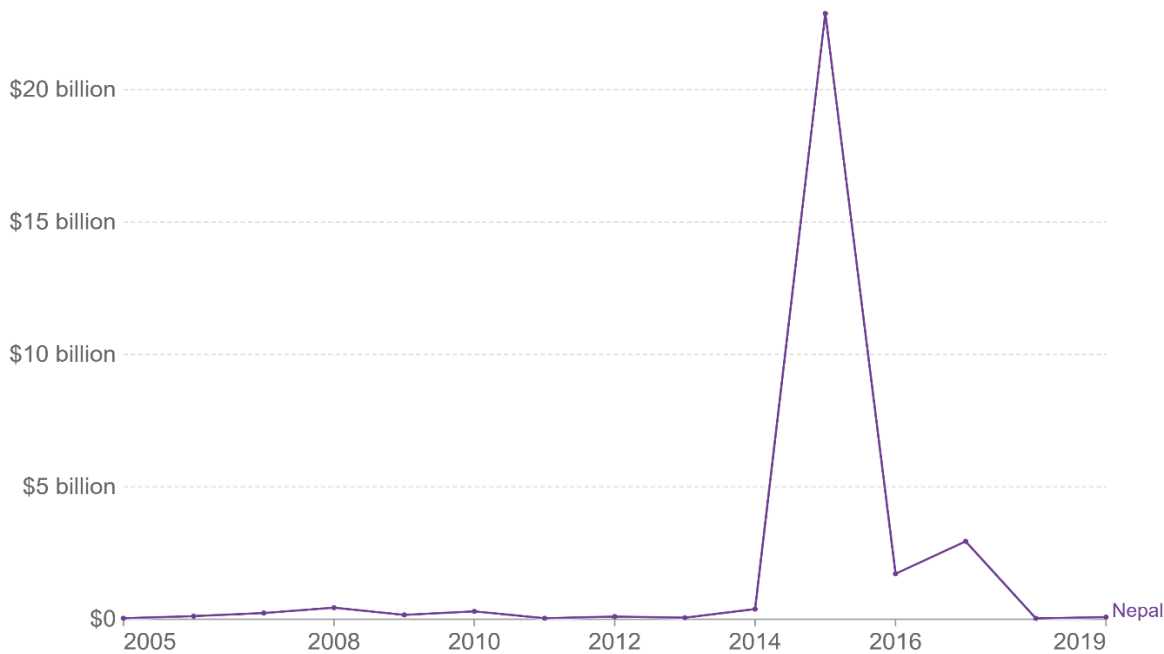
world. It has had faced numerous catastrophic disasters in the past years that claimed thousands of lives and huge loss of property (Gaire et al., 2022). Earthquakes, landslides, floods, etc. are the major disaster disasters that have caused a significant loss of lives and property which has become the major reason to weaken the ecosystem of the country. They have also been severe enough to pose a threat to the nation's physical infrastructure eventually leading to an imbalance and hindering the economic development (NDRR, 2023).

As per a study carried out by ADRC, Nepal falls in the top 20 list of the most multi-hazard prone countries in the world. The country is ranked, 4<sup>th</sup>, 11<sup>th</sup> and 30<sup>th</sup> in terms of climate change, earthquake and flood risk respectively. It is seen that the economic cost associated with natural disasters has increased enormously. Besides geological, ecological and hydrological phenomena, rapid population growth leading to environmental degradation, poverty, poor building practices, insufficient emergency preparedness, lack of awareness and political instability have been the reasons for disaster vulnerability in Nepal.

Every year Nepal faces several disasters throughout the year resulting losses in millions of USD. The recurring disaster events of earthquake, landslides, flood and wildfires affect significantly in the national GDP. From the 1980s to 2017, the country lost 21,000 lives and about \$5.9 billion of direct physical losses and affected lives and livelihood of around 13 million people. The Earthquake of 2015 claimed lives of more than 9000 people leaving more than 23000 injured and causing an economic loss of \$7.1 billion which is equivalent to 35.7% of total GDP. The nationwide flood of 2017 inundated almost 80% of the Terai that led of millions of losses as Terai is a major economic hub. The estimated recovery need is \$705.1 million. As per research, Nepal annually faces an average loss of \$173 million caused by natural disaster which is equivalent to 0.88% of total GDP as of 2014 (Van, 2018). Nepal gets support from various National and International agencies that work for disaster relief and mitigation such as ReliefWeb, Red Cross, Oxfam and many more. The following chart will give a timeline of economic loss caused by disasters from the year 2005 to 2019. The highest is recorded in the year 2015, the economic loss is more than \$20 billion as the country was hit by 7.8 Richter scale Earthquake prior to economic blockade and then followed by year 2018 during nationwide flood.

## Direct disaster economic loss, 2005 to 2019

The monetary value of total or partial destruction of physical assets existing in the affected area. Direct economic loss is nearly equivalent to physical damage.



Source: UN Statistics Division

OurWorldInData.org/natural-disasters • CC BY

*Figure 1 Economic damage caused by disaster (2005-2019)*

The ministry of Home Affairs has been working as a nodal agency of disaster risk management in Nepal. Based on the Hyogo Framework for Action, the government of Nepal has adopted National Strategy for Disaster Risk Management (NSDRM). Similarly, Disaster Risk Reduction (DRR) and Climate Change Adaptation were the national priority and were emphasized in the 10<sup>th</sup> Five Year Plan (2002-2007). Ministry of Home Affairs has also established a National Emergency Operation Centre (NEOC) and a Multi-level Hazard Risk Assessment with support from the World Bank. Early warning strategy is in progress. (Dangal, 2011)

### **2.4 LANDSLIDE HAZARD, RISK AND DAMAGE IN NEPAL**

Disasters have been taking place since the earth's formation. Different kinds of disasters take place around the world with every passing time; Earthquakes, Tsunami, Tornadoes, Landslides, Volcano Eruption, wildfires to name a few. According to NASA (2023), Landslides are one of the most prevalent hazards in the world that cause thousands of casualties and damages worth billions of dollars every year. Landslides triggered by intense rainfall are hazards that have impacted infrastructures and people all around the world. Despite small in area, landslides can cause significantly greater impacts, resulting in debris runout that can go miles far. Such events are

responsible for blockage of roads, infrastructural damage, trigger other disasters like flood, and kill thousands of people (Emberson et al., 2020).

Landslides have been a major disaster in Nepal as well, claiming lives and property annually. Landslides in Nepal usually occur as effects of heavy rainfall and earthquakes and can be triggered by both natural and man-made reasons. Steep slopes contribute the highest to a susceptibility of landslides, followed by deforestation, presence of roads around the hills, the strength of bedrock and soils and the location of faults as mentioned in a report by NASA (Voiland, 2017). The frequency of landslides has been increasing rapidly every following year (figure 2).



Figure 2: landslide frequency for 10 (: GoN, 2023)

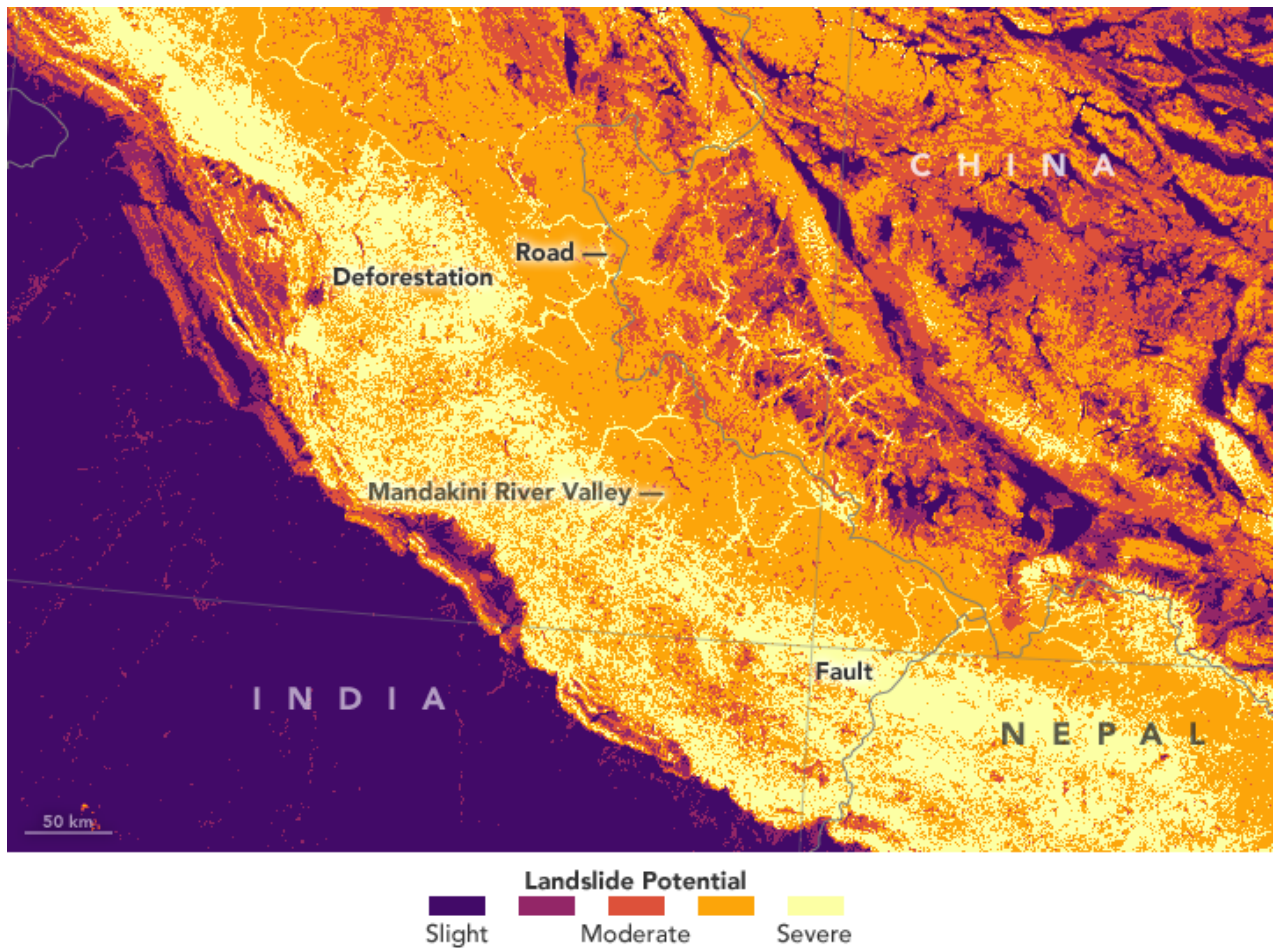


Figure 3 Landslide potential near fault region, (NASA, 2017)

The figure above is a picture taken for landslide susceptibility by NASA and Nepal is in the fault region, and the index show that the country has moderate to severe landslide potentials around the area. In reference to above mentioned causes, Nepal has high susceptibility to landslides.

Since Nepal lies in the fault region, movements below the earth are one of the suspects of debris flow and landslides when it rains heavily. Highway constructions in the hilly regions have been found to be responsible for increasing the likelihood of landslide occurrence as they add up in the constant tremors. Roads have been constructed along the uneven topography that have deep river valleys and mountain ridges making the hilly region more susceptible to landslides. When the people see that roads are constructed, they move their settlements nearby which increases the chances of human and property loss when landslides occur. (Nepal et al., 2019). Road issues and related landslides have persisted for a long time but are little-researched phenomena. In an early analysis conducted by Laban on how human development affects the distribution of landslides in Nepal, he came to the conclusion that only 5% of recorded landslides were connected to roads

during the early stages of the country's development of motorized roadways. However, it was seen to have more than quadrupled from 13.7 km<sup>2</sup> in 1998 to 49.6 km<sup>2</sup> in 2016 (DoR, 2002, 2017). Petley and his team revealed that the frequency of landslide fatalities in Nepal substantially rose between 1978 and 2005 and which reasonably raised concern over poorly built roads in Nepal (Petley et al.,2007). In the absence of professionals' supervision, the undercutting of slopes may lead to allowing water to infiltrate into hazardous slide planes, and producing debris that is easily mobilized following heavy rainfall, the ensuing informal roadways frequently cause landslides. Also, in the terrains that have loose soil type and the access to heavy equipment speeds up road building, and the landslides that are triggered as a result disrupt transportation networks that transport daily needed goods and services to and from rural communities. They also harm agricultural lands in areas where subsistence farming is the norm and might result in several fatalities each year. These phenomena continue every year and people suffer in the contrary to their hopes and beliefs of developmental gain as road constructions have tangible and immediate effects.

The Earthquake of 7.8 Richter Scale on 2015 triggered 20,000 landslides in Central and Western Nepal. With the continued tremors and rainfalls that followed, news of landslides became common. Earthquake triggered landslides are not uniform, however they can always carry a significant threat for potential future hazard as the debris release can vary according to soil conditions, i.e., either dry or with moisture. Since Nepal is prone to earthquakes of varied intensity, landslides that follow up can differently depending on the seasons in which earthquake occurred (Rosser et al., 2021).

According to research carried out by Sudmeier-Rieux et al. (2013), landslides have an underestimated impact on livelihood and food security in Nepal and a very little attention is received from government despite having several organs to look after the issue. In the Fiscal Year 2021-2022, there were 310 reported cases of landslides with 92 deaths and 80 injured, leaving 1968 families affected, and around 2200 infrastructures damaged which included 2 hydro powers. The national relief fund spent \$47.5 million in the same year for disaster management fund (DRR, 2023). With the increasing trend of landslides as shown in figure 2, if proper pre-disaster steps are not taken, then the country might have a difficult time overcoming the economic burden.



## **2.6 LITERATURE REVIEW**

The study focuses on community risk assessment, and I have taken a few research papers as references. According to the papers that were selected and reviewed, it was shown that community risk assessment can be an important step to reduce damages caused by various disasters. The selected papers have focused on terrain lands, monsoon and road development as major reasons for increased frequency and intensity of the landslides and damages caused by them.

The research carried out by McAdoo et al., argues that number of people who have lost their lives because of landslides in Nepal has been steadily climbing due to a complicated combination of factors, including earthquakes, climate change, and an explosion in the construction of informal roads, which destabilizes hillsides while it is raining. It also claims that this trend is likely to increase as development continues, particularly as China's Belt and Road Initiative seeks to construct three major trunk roads through the Nepali Himalaya and as a result the neighboring communities will seek to try to connect to these roads so as to have a better and easier trade and life. They believe this has allowed them to determine the effect that those informal roads have on the generation of landslides. The authors believe that when it rains heavily during the monsoon season, the over steepened slopes, inadequate water drainage, and inadequate debris management create the required conditions for inducing a landslide.

The other study carried out by Vans Aalst and team show the potential role of a participatory community risk assessment. Throughout the paper one can see how the authors have explored the value of using community risk assessments to reduce risks induced by disasters. In the paper, they have focused on climate change adaptation, nonetheless, they have successfully portrayed the importance of community-based risk assessments. The authors have highlighted the challenges of integrating global climate change into a bottom-up and place-based approach. According to the results, the mentioned challenges can be addressed through community engagement (Aalst et al., 2008). The reason behind choosing this research as a reference was to incorporate the community risk assessment theme with a better understanding.

Another study that took place in Far West Nepal showed how the perceptions of risk and resilience are interconnected with indicators of risk resilience. The authors explored various factors that affected the perception of risk. This article will help understand the perception towards risk and resilience of community people which is a crucial factor to build resilience building plans and disaster reduction (Martin et al., 2021). This article will help understand the disaster risk perception

and resilience of the community people of Siddhalekh which is essential to carry out the assessments for risk reduction.

<b>Major Reason for Landslides</b>	<b>Consequences</b>	<b>Mitigating solution</b>
<b>Undercutting slopes for development purpose i.e., road expansion</b>	Hindrances in day-to-day activities Effects on agriculture and cattle	Bottom-up/place based, community risk assessment
<b>Monsoon rain</b>	Settlement problems	
<b>Loose soil</b>	Economical stress	
<b>Wildfire</b>	Social disturbances	

*Table 1 Conceptual Framework, (literature review 2.6)*

The above table (table 1) is a conceptual framework formed after the literature review was done. After going through various literatures, besides the natural trigger of landslides, man induced triggers were found to be responsible for increased landslides. The development work going on nationwide has played an important role in increasing the frequency of landslides. The changed pattern of monsoon rain resulted by climate change has been another alarming reason for the increased frequency of landslides. The rise of urbanization has led to deforestation which affects the holding capacity of soil. In addition to it, the surge of wildfires right before monsoon season has fueled the hazards of landslides as the loose soils are washed with the monsoon rain. The untamed hills have topsoil and fresh excavated hills are more prone to debris flow. All of the mentioned reasons trigger landslides, and the consequences are not pleasant. Regardless of the intensity of landslides, the debris flow can have a significant number of effects. The community people as well as travelers face hindrances to their daily activities and businesses. Farmers' income is affected as the agriculture and cattle are damaged. People will have settlement problems when the landslide occurs as their habitat is either damaged or inhibited. When people get homeless and income source is hindered, they are susceptible to go through economical and psycho-social stress. These aftermaths of landslides can be mitigated, and prevention of events is possible with a bottom up or community-based risk assessment. This is a feasible method as the researchers can discover underlying causes of landslides. Community participation will help in the gathering of information and since it will be included, the feasibility of solutions can be discussed from the beginning.

## **CHAPTER THREE**

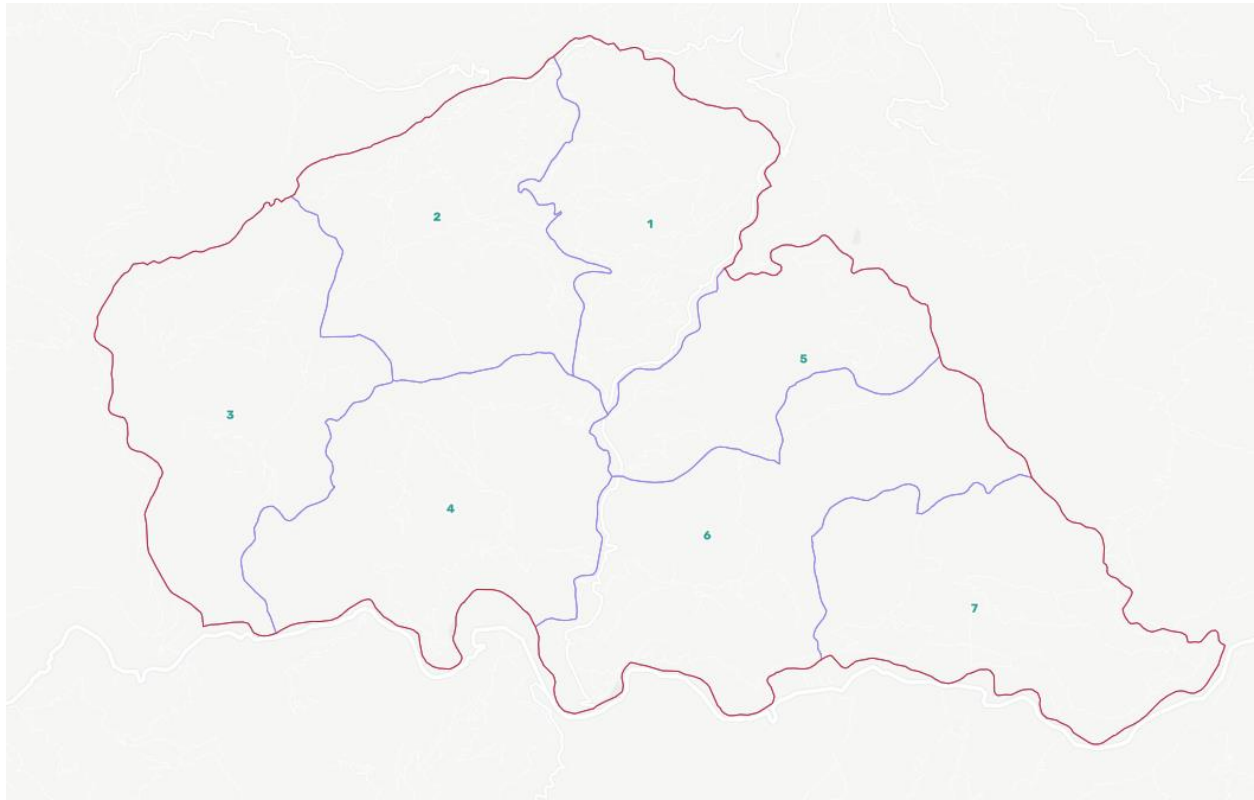
### **CONTEXT OF THE STUDY**

The study area is in Siddhalekh Rural Municipality where there are numerous villages which might be at risk if landslides induced by heavy rainfall occur and this chapter describes the study area in detail.

#### **3.1 SIDDHALEKH**

Situated at just 12km from the headquarter Dhadingbesi, Siddhalekh rural municipality got its name from the tourist attraction site Siddhalekh which has Siddhababa. Siddhalekh Rural Municipality was formed in 2074 B.S. (2017 A.D) after merging the former village development committees namely Salang, Nalang and Kumpur under provincial government. According to Census data of 2021, Siddhalekh has a total population of 31,395. And its total area is 106.01 km<sup>2</sup>. Siddhalekh rural municipality has a total of 7 wards. All of the wards have access to gravel roads which only are accessible during winter. The people here are mostly dependent on agriculture and 55% of the total land is fertile and cultivable. Siddhalekh has a multi-diverse cultural group in the settlements where Brahmins (24.95%) which is the highest followed by Magar (18.64), Dalits (18.05), Newar (15.46) and tens of more among which Hinduism followers comprise the highest population (42%).

As the country moves towards development, we can see the shift in income sources of the population. 30% of total population is found to be relying on foreign remittance whereas 19% of the population earns its income through business and only 6.74% earns it through agriculture. Despite the income source is lowest through agriculture, surprisingly, 39.54% of the population's major occupation is agriculture (Siddhalekmun, 2018).



*Figure 4 Map of Siddhalekh Rural Municipality, (GoN, 2023)*

### **3.2 LANDSLIDE IN SIDDHALEKH**

Siddhalekh rural municipality is situated in a hilly region ( $27.84^{\circ}\text{N}$   $84.81^{\circ}\text{E}$ ). It lies in central hilly region of Nepal which lies 1400m above the sea level automatically adding in the risk of Landslides. It is comprised of hills and rivers. According to census survey 2021, almost 19 different places are in risk of landslides which includes 79 houses in the area.

Every year, monsoon rain is the major cause of landslides followed by sloped terrains and soft rock beds in the area. As the hills are being transformed into road tracks the unmanaged and not completed roads are hampered by the monsoon rain and blocked after landslides.

Before coming up with a plan to assess risk, identification and assessment of hazards and vulnerabilities is required. The monsoon season is one of the risky times of the year as it is not only capable of nurturing the crops but also destroying them. Rainfall is the major reason for disasters like landslides, flood, and erosions to occur whose intensity also is affected by the amount of rainfall. In Siddhalekh rural municipality mudslides and erosion are very common followed by landslides which are triggered by rainfall along with other reasons. Besides geography, earthquakes have played an important role in the occurrence and intensity of landslides. Therefore,

it is important to have an assessment of underlying hazards that could lead to changes in potential risks if a disaster is to take place. The following table shows the landslide susceptibility of Dhading where it is clear that Siddhalekh Rural Municipality has a low to medium risk of landslides in comparison to other areas. However, if proper assessment and precautions are not taken, it may lead to severe consequences.

S.N.	Ward no.	Flood and landslide susceptible and affected areas	Landslide	Flood
1	1	Nalang Secondary School		
2	1	Ekle Baadh Landslide		
3	1	Bungchung Naagaithan		
4	1	Kalidaha		
5	1	Damai Thumko		
6	1	Pahire Bhattarai Dada		
7	1	Dhara Pani Lede Khola Area		
8	2	Kandepani Dada Landslide	18	
9	2	Kamere Pakho	20	
10	2	Faale Chitaure Village Landslide		
11	6	Niwuwa Majhitaar	3	
12	6	Siddhalek 6 Humli Tol	17	
13	6	Siddhalek 6 Pipple	9	
14	6	Nepaltaar	5	
15	6	Majhitaar	7	
16	7	Bhaise Pokhari Seto Landslide		
17	7	Landslide from Ghat Besi to Peepaltaar's Pul Jip Bridge		
18	7	Landslide of Jaalpadevi Temple		
19	7	Barhamude Chyandada Landslide		
		Total	79	

*Table 2 Flood and landslide susceptible and affected areas-translated, (Siddhalekh mun, 2017)*

Table 1 is derived and translated from the annual census report from the official webpage of Siddhalekh rural municipality. The table illustrates the total number of landslide events and susceptible areas in Siddhalekh, with Kandepani Dada Landslide with 20 landslides events and areas. Out of 19 susceptible areas 7 of them have recorded frequent events of landslides.

### **3.3 LANDSLIDE INDUCING ACTIVITIES IN SIDDHALEKH**

In comparison to other development works, road construction is on the top as it has immediate benefits. They reduce the menial and tiring process of walking on trails, especially on an upward hill with loads. The people support development of roads as they will get to commute easily, farmers will have a hope to access markets more easily, students will get to attend schools without

having to walk through dangerous paths alone and so on. With the access to roads, the settlement patterns change as the people tend to buy lands that are adjacent to roads for better opportunities. They try to ignore the little knowledge they have about landslide risk and choose to profit by seizing economic opportunities near newly built roads.

As mentioned above, humans are inclined and attracted towards better facilities and an easy life which more or less is inaugurated by roads and transportation. Community people agree to extend the roads across the lands they own with the little incentives they get. The local politics moves around construction of roads. People get attracted to the future benefits they will be getting from the newly built roads (Dixit et al., 2021). Siddhalekh has a total of 206 kilometers worth of roads with approximately 20 kilometers being tarmac and the rest being graveled. These roads, however, have limited usability, because they are subject to landslides due to monsoon rain. Harsh rainfall that are inherent at Siddhalekh, coupled with unmanaged farming, slopy hills and careless grazing are some of the factors that contribute to the loosening of the integrity of the soils and cause debris flow. The untamed hills and newly extended roads take a lot of time to get tarmacked, leaving extra room for landslides and mud pour to occur.

People here depend on seasonal farming, and Siddhalekh can have dry winters and hot summers, which creates an extreme change in the climatic condition. As population rapidly increases and developmental works continue, environmental degradation increases. When the winter ends, villagers burn the hills, where accessible, to help nourish the hills with ashes and let new plants grow. However, this activity has a negative impact, it can help trigger landslides as wildfires can remove vegetation and ground cover. The dry and windy season exaggerates the fire and combustion of small area changes into wildfires that are unstoppable. This results in reduced capacity of soil infiltration and increased soil erodibility (Rengers et al., 2020).

### **3.4 JUSTIFICATION FOR SELECTING SIDDHALEKH AS STUDY AREA**

Siddhalekh is prone to various natural disasters, and landslides are one of the most recurring ones. In the wake of landslides people lose their properties, and even lives. At times when the landslide events are not of high intensity but strong enough to hinder daily life, they just carry on with their lives by helping each other. The lack of coverage in the media and news of events not reaching respected authorities on time has amplified the sufferings of community people in village areas. One of the major reasons to choose Siddhalekh as a study site is due to the ignorance faced by the community. In comparison to other rural municipalities, Siddhalekh has relatively less researches

carried out despite being prone to such risks. Despite being within the proximity of the district headquarters, Siddhalekh seems to be not getting enough attention and this is the reason for choosing Siddhalekh. Choosing other places such as Nilkantha municipality, Ruby Valley would have just repeated the data and the areas that have not yet been explored. Ruby Valley is one of the topmost landslide prone areas and the top researched rural municipalities in Dhading regarding landslides. Hence, the research site was chosen to be Siddhalekh. In addition to the above-mentioned points, Siddhalekh is the researcher's hometown and wants to put the knowledge into practice. This will facilitate the community to get evaluated and assessed as well as it can be a steppingstone for giving back to the community.

This research aims to understand the community perceptions, livelihood options and assess the vulnerability that is resulted by landslides in the region through a process of Community based risk assessment, which provides a crucial point for the significance of this research. Due to its remoteness and lesser exposure to media, there was not enough research carried out. Through this research, the investigation for the required points about the measures needed to prepare the community people to work against the hazard of landslide risks will be done which will aid in community's resilience building as well. The research will help provide a basis for further studies and will serve as a reference for the concerned authorities as well as stakeholders.

## **CHAPTER FOUR METHODOLOGY**

Chapter 3 justified the reasons to select Siddhalekh as a study area and discussed the study area in detail. This chapter will thoroughly go through the research methods, tools and analysis for this research. It further includes the research framework followed by the explaining Community based risk assessment and its tools. This chapter is the longest one in the research as it discusses CRA tools and methods as well.

Primary and secondary data are used in this study. Field visits along with surveys, interviews and group discussion were done to extract primary data. Frequent visits to the study site and discussions with the local people were done as per need. Secondary data was extracted from a variety of sources including newspaper reports, government datasets, NGO documents, scientific papers etc. The secondary source and collection of data, analysis along with measures are taken into consideration while drafting this paper. Primary data was required as the research in the selected area had inadequate information. The information was to be collected firsthand to be able to get accurate results. Secondary data was taken as reference to collect and analyze the primary data. They would be contributing in comparison of primary and secondary data. The following points show the overall research methodology followed in this research. Secondary data were collected from journals published, newspaper articles, books, web search, official records on government websites etc. Document reviews were done before the first transect walk. They were read and reviewed to take references and gain more understanding on landslides risk assessment.

### **4.1 RESEARCH APPROACH**

This is an exploratory research approach that follows content analysis with the use of various data collection tools such as questionnaire survey, focused group discussions (FGD), semi-structured interview and case study. The research follows both qualitative as well as quantitative methods of data collection and analysis. The reason to choose exploratory research method was because landslides in Siddhalekh was not taken as a research area and it would help in identifying patterns and trends of landslides and ways to mitigate them. Since the research has less numerical data and information would be gathered qualitatively, this research method was found to be convenient. which helps to enhance validity and credibility of findings. Pritha Bhandari (2022) defines triangulation as use of multiple datasets, methods or theories to address a research question. Therefore, to avoid any research bias, the information obtained through questionnaire survey were



validated through methodological triangulation of data with other research tools: focus group discussion and semi-structured interview. Since the research is qualitative based, this approach seemed feasible and stronger. The research took place in different intervals of times due to COVID-19 pandemic and on-off lockdown situations countrywide, hence, to avoid any research bias and to utilize the time, other methods were not applied.

The questionnaire survey was done in the schools and community halls to gather information on knowledge related to landslides. As the research was done during the times of pandemic, questionnaire survey had to be done in different time according to the lockdown timings. This helped in yielding information from a large group of people at once. After the lockdowns and restrictions were lowered down, the remaining methods of data collection were used. Focused Group Discussion with 8-10 people were done. A total of 10 groups from around the rural municipality were involved in FGDs where questions related to landslides and their experiences were used as leading questions in the discussion sessions. Semi structured interviews were taken after the group discussions were done. They were asked questions and later let to be expressive on their thoughts and suggestions. Case studies were used as the basis of reference and comparison tools for the acquired information.

#### **4.2 UNIT OF ANALYSIS**

The stakeholders are the teachers in school and government personnels of the rural municipality office, and the information collected from them is the unit of analysis in this research. The respondents of this research are the local people of the community who have lived in the region for more than 10 years. Students of secondary level were asked about their knowledge on landslides and their past experiences related to landslides, if any.

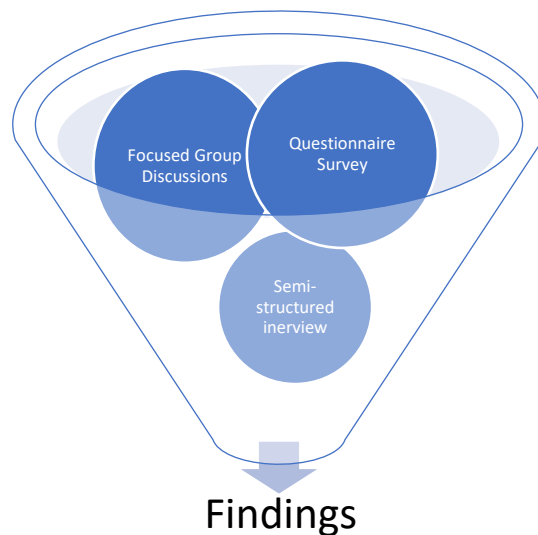
#### **4.3 DATA COLLECTION**

The data collection for the study was done through focus group discussion (FGD), semi-structured interview/key informants' interview and literature review of secondary data. The study was carried out within Siddhalekh rural municipality, where primary information was collected from various field visits in the form of transact walks. While on field visits, the responses were recorded, jotted down and filled up in questionnaires. 80 secondary level students from the major schools were selected and a questionnaire survey was conducted to assess knowledge on landslide risks and gather demographic data. The reason to select schools was because of the diversity and the students

came from all areas of the research site, which gave an insight to select the areas to carry out further study. Further detailed data collection information is to be found in chapter 5.

#### 4.4 DATA ANALYSIS

Content analysis and methodological triangulation was followed to analyze the obtained qualitative data. A research tool used to determine the presence of certain words, themes, or concepts within some given qualitative data such as texts, audio and videos is known as content analysis. Content analysis is used to quantify and analyze meanings and relationships of words, concepts and themes from data gained from interviews, research notes, discussions, media as well as historical documents (Columbia University, 2023). As suggested by (Mikkelsen, 2005), there are five types of triangulations: Data triangulation, Investigator triangulation, Discipline triangulation, Theoretical triangulation; and Methodological triangulation. This research follows methodological triangulation. Methodological triangulation refers to the employment of several methods in qualitative research to extrapolate information through comprehensive understanding (Patton, 1999). The relevant qualitative data from questionnaire survey, semi-structured interview and focus group discussions were extracted and cross checked to test the validity through the convergence of information from these research tools. Further analysis of obtained data was done by using MS Excel where interpretation was in the form of pie charts and bar diagrams. Following figure 7 shows methodological triangulation of data obtained.



*Figure 5 Methodological Triangulation of data, (Author, 2023)*

The overall research framework for the dissertation is presented below:

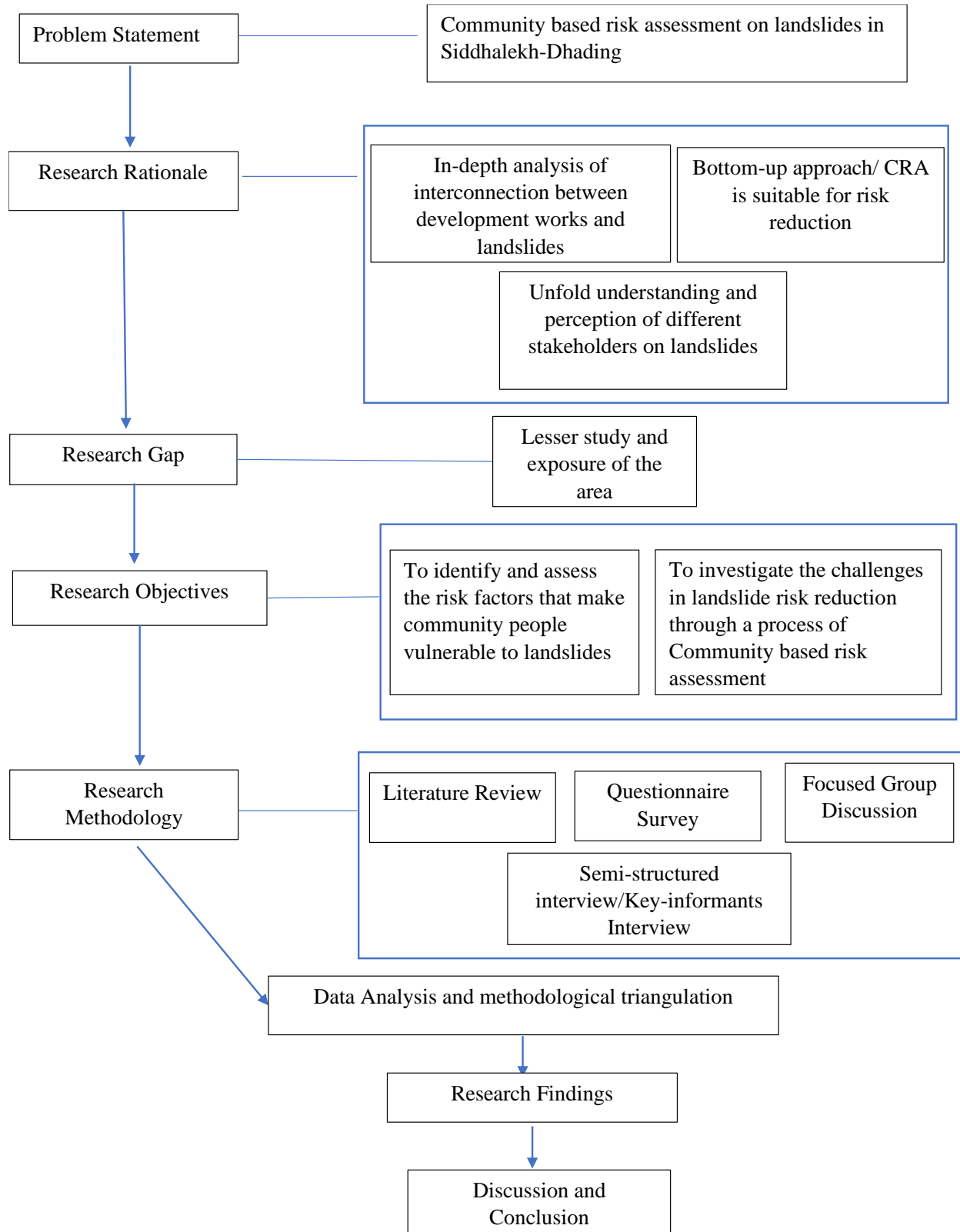


Figure 6 Research Framework, (Author, 2023)

Along with the mentioned tools, assessment of Hazards and Vulnerabilities was carried out and several CRA activities were carried out in order to gather data. Those activities and processes are further explained in the following chapters.

## **CHAPTER FIVE**

### **DATA COLLECTION AND ASSESSMENT**

Before coming up with a plan to assess risk, identification and assessment of hazards and vulnerabilities is required. The monsoon season is a sort of double-edged sword as it is not only capable of nurturing the crops but also destroying them. Rainfall is the major reason for disasters like landslides, floods, and erosions to occur whose intensity also is affected by the amount of rainfall. In Siddhalekh rural municipality, mudslides and erosion are very common followed by landslides which are triggered by rainfall along with other reasons. Besides geography, earthquakes have played an important role in the occurrence and intensity of landslides. Therefore, it is important to have an assessment of underlying hazards that could lead to changes in potential risks if a disaster is to take place. The assessment has its own tools and techniques.

#### **5.1 COMMUNITY BASED RISK ASSESSMENT**

Communities themselves are the first responders in case of any disaster. The communities do not always have access to external humanitarian intervention during times of disaster. Various factors such as time, geography, resources etc. limit their access to relief. Hence, the immediate after response activities are carried out by family members, relatives and neighbors who are the people of community. In a small-scale disaster, the community people are left entirely on their own. Communities have critical knowledge, experience and capacity with regards to building resilience, and have developed innovative approaches to reducing the everyday risks they face. In addition to it, the top-down disaster management often fails as they are unable to address the specific needs of at-risk communities. Communities have limited access to relief and external humanitarian assessment during the time of disaster hence as a coping mechanism, the community people learn to tackle the disasters with whatever resources available. Therefore, a community-based disaster risk management approach should be the core of any risk reduction approach. Community-based disaster risk management approach (CBDRM) is a process, which leads to a locally appropriate and locally 'owned' strategy for disaster preparedness & risk reduction. Community-Based Disaster Risk Management (CBDRM) is the result of this realization and aims to create opportunities and build partnerships with the communities to establish disaster-resilient societies. Yodmani (2001) defined community-based disaster risk management as an approach that reduces vulnerabilities & strengthens people's capacity to cope with hazards.

A community risk assessment is an initial step to ensure the sustainability of intervention by measuring ground risk. Participatory risk assessment is a method that builds a relationship with all community people and engages communities, using a highly participatory approach in a bottom-up fashion. It gives some insights into how risks are created and can be reduced. In applying the participatory methods, a community risk assessment (CRA), as its key tenet, is a concern to put local communities at the leading-edge of the disaster risk and vulnerability identification process, thereby residents themselves are allowed ownership and monitoring of the assessment. Thus, CRA assistance is done to make a framework for a mutual exchange of information and the development of strategies between local people and other authorities or stakeholders.

## **5.2 PRE CRA-STEPS:**

**5.2.1 *Selecting Community:*** Landslides are one of the most common and devastating disasters in Nepal. Annually they affect the development infrastructures, lives and properties of people. The placement of villages in hilly areas that are either on hills or close to unstable slopes as well as recurring landslides triggered by rainfall are the main reasons for the losses every year. The country is developing its infrastructures, construction of roads being the major one (Thapa, 2015). As much as the development works are benefitting the lives of people, it has been affecting nature causing natural hazards to contribute in triggering the landslides. Siddhalekh in Dhading district is experiencing rapid changes in infrastructural development after the earthquake which is a good thing. Previously independent VDCs Kumpur, Salang and Nalang, now merged into single Rural Municipality were selected as study areas. Kumpur and Salang have a higher risk of fatal landslides than Nalang. The reason for selecting this community is to study the trends of landslides and possible risks in the areas where the newly built roads are located. All the three major village communities are developing infrastructural development mainly in electricity and transportation rapidly. After the roads were built, the locals felt that their lives became easier. However, due to lack of slope stabilization after the hills are cut to paved roads, the remaining debris and delayed asphaltting (kalopatre) of the newly built roads make the lives even harder during the monsoon. This has resulted in mud pouring along with damage to the roads creating difficulty in daily activities too. Another reason to select Siddhalekh as the study site was the dependence in agriculture. Many agricultural lands are destroyed to construct roads and erect the electric poles. This has somewhat decreased the income of the families as they rely on revenue from crops, they sell.

After checking the official website of municipality, it was found that, Siddhalekh rural municipality doesn't have records of deaths caused by landslides, yet economic loss and disturbances in daily lives was an inevitable effect of landslides. Siddhalekh rural municipality was chosen as the study area due to the increasing number of roads built every year and the side effects of slope debris. Despite having no records of human casualty, the area was chosen to mitigate any future casualties.

### **5.3 TOOLS OF CRA**

**5.3.1 Transact Walk:** To yield better and clear understanding of the locality and its natural resources, land use, local problems, prospects etc. from the local people as well as to be familiar with the locality transact walk was done which helped in identifying and verifying the information gathered. Throughout the transact walk, the villages and the newly constructed roads were visited to check the differences in daily life before and after the roads were constructed. Transact walk also helped in familiarizing with the community people who tried to recall their memories regarding the landslides.

**5.3.2 Social Mapping:** Social mapping provides a better understanding of past events of disaster that affected people's lives and the environment. It also helps in knowing how disasters have affected the community's resources over the years and evaluate the negative impacts. This also provides the researchers with a skeleton on where and how to conduct the assessment or research.

**5.3.3 Focused group discussion:** The discussion is used to gain information about the locality, people, their livelihoods, local risk environment (hazards) and local/traditional preparedness and coping strategy. The discussion was mainly based on the concerns about disasters by local people. This information will be useful in validating secondary data and new information can be incorporated that may have been missed during the transact walk.

The following table shows the major questions that were used for FGDs.

<b>Understanding Landslides</b>	
1.	Do you know about landslides?
2.	Do you have any knowledge on how landslides occur or what could be the causes?
3.	Do you have any knowledge on how to reduce the risk from landslides?
4.	Has there been any landslides in the last 10 years?
5.	Were there any damages done by landslides in the last 10 years?
6.	Have you noticed any changes in the patterns of landslides in the last 10 years?
7.	In your opinion what could have been responsible for the changed intensity and frequency of landslide in the area?

*Table 3 Questions employed in FGD*

**5.3.4 Key informant interviews:** To gather information from each of the affected local people. The information consists of their livelihood and the experiences from them. They will be providing us with various information regarding history of disasters (landslides), how they cope up, effects and changes take place. A total of 35 key informants were selected after group discussions. Teachers from schools as well as leaders of village community groups along with people who had 1<sup>st</sup> hand experience were selected and interviews were taken. The table below shows the engaged stakeholders.

<b>Stakeholder</b>	<b>Impacted</b>
<b>Primary Stakeholder</b>	Farmers, Day labor, Children, Women
<b>Secondary Stakeholder</b>	Local administration, political leader, Government and NGOs personnel

*Table 4 Stakeholders*

Semi-structured interviews were conducted to explore various topics related to landslides and coping mechanisms.

Following table (table 5) shows the list of questions that were employed during the interview:

<b>S.N.</b>	<b>Landslides, past experiences and mechanisms to tackle</b>
1.	How long have you been staying in the village?
2.	Have you noticed any changes in the weather pattern and how has it been affecting your livelihood?
3.	Have you experienced any natural disaster in the last 10 years?
4.	What was the aftermath of the disasters?



5.	How did you cope with the aftermath?
6.	How do you feel about the road expansions going on in your area?
7.	What do you think you can do to tackle the susceptible landslides? Or do you think anything needs to be done?

*Table 5 Questions employed during interview*

**5.3.5 Hazard Venn-diagram/mapping:** Information on different hazards according to intensity, effects and frequency of occurrence in the study area was collected. A hazard Venn-diagram is created after finalizing the hazards that can affect the intensity of risk in a certain area. The hazards are presented in the circles according to their prospective intensity i.e., bigger the circle greater the hazard.

The outcome achieved from the use of tools above is shown in the following chapter.

#### **5.4 OUTCOME OF ASSESSMENT**

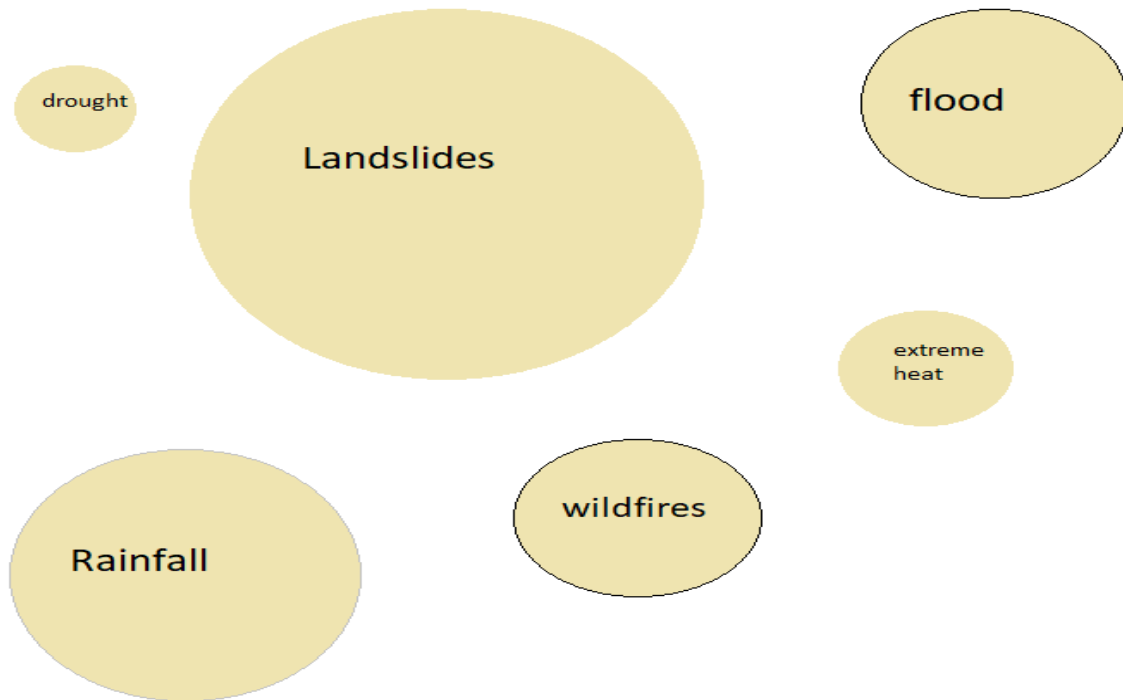
With the above discussed tools, the study area was assessed so that further steps of CRA could be conducted. Transact walk gave us information related to economic and social activities needed for social mapping. Due to the pandemic and frequent lock downs imposed nationwide, the transact walk was not as smooth as it was planned. However, phone calls were made before moving towards the study site to make sure the environment was safe for outsiders as well. Nonetheless, we got the information that was required for the continuation of research.

Starting with demography, the population of Siddhalekh Rural Municipality is 23,729 as of the census conducted this year with 16,316 male (51.97%) and 15079 (48.03%) female. Main crops of the area are maize, sesame, mustard, peanuts, barley, tomatoes and season vegetables varying the altitude and settlements. As the country moves towards development, we can see the shift in income sources of the population. 30% of the total population is found to be relying on foreign remittance whereas 19% of the population earns its income through business and only 6.74% earns it through agriculture. Despite the income source is lowest through agriculture, surprisingly, 39.54% of the population's major occupation is agriculture (Siddhalekmun, 2018). The terrains are not easy for manual irrigation, so agriculture is dependent on the rainfall. However, the crops are sometimes destroyed by heavy rainfall with occasional hailstorms. The regular cultural activities are affected with the variation of entrance of monsoon in the country. The villages have population of mixed ethnicity.

Focused group discussion was done among various groups which gave similar outcomes. The participants of focused group discussion came from all backgrounds including villagers to teachers and students to government officers. The main aim of taking participants from all backgrounds was to cross check the reliability of the information given as well as to compare the data. The number of participants varied according to their availability and took place in either communal hall or “Chautari” of the settlements. Each FGD involved adults both male and female ranging from age 30 to 65, at times 70 years. The focus group discussion targeted to observe the basic understanding of the local people on landslides and if their livelihood has been impacted. The discussion took place in Nepali and at times in Magar language where the old people were unable to understand. All the 10 FGDs were either audio recorded or penned down and later transcribed and edited for data analysis. The information obtained from FGD was later validated through methodological triangulation.

The key informant interviews helped in understanding the perceptions of participations on landslides and to explore if there have been any actions taken to minimize the observed impacts. In this section as well, use of simple words was used and communication in Magar language was done where needed. Further discussion on outcomes of FGDs and key informant interviews are discussed in chapter 6.

For hazard mapping, it was found that rainfall is the major hazard that creates risk of landslides, floods and mud pouring. Rainfall also affected the productivity of crops. On the contrary, occasional droughts were responsible for delayed farming along with travel to farther places to fetch water. With the monsoon rain, debris flow and landslides were common. The community seemed to be more worried about their cultivation and animals than themselves.



*Figure 7 Hazard Venn-diagram throughout the year (Author,2022)*

Figure 7 shows the hazard Venn-diagram throughout the year. The hazard circles given are shaped according to their strength or capability to create vulnerability and affect the people. Landslides create the biggest hazard followed by monsoon rainfall in the community. Similarly, wildfires and floods have similar amount of hazard whereas drought and extreme are not that hazardous to the community as the events are low. These are potential hazards that can become disasters any time if proper preventive measures are not taken. The diagrams were formed on the basis of responses gained from the local people. They were asked about the hazards that occurred throughout the year. The diagram was completed according to the risk of hazard and their frequency throughout the year.

Table 6 shows the seasonal hazard mapped throughout the year. Rainfall related hazards and floods are most common during monsoon, i.e., May to August. The community is prone to landslides during the early monsoon months to end of monsoon. Droughts are occasional before monsoon and during winters. During the months of March, April, and May, wildfires occur as farmers tend to set the dry lands and vegetations on fire to accelerate the growth of new plants and ashes work as manure. Extreme heat is recorded from early May to late July.

Hazard mapping Months	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Rainfall												
Monsoon flood												
Landslides												
Drought												
Wildfires												
Extreme heat												

Table 6 Seasonal Hazard Mapping, (author 2022/data collection)

### DATA COLLECTION SUMMARY TABLE

The table below is a summary showing the number of visits to the study area throughout the data collection period. Some of the visits have a large gap due to pandemic restrictions:

Visit	Time of the year	Place	Reason
1.	March 01-March 05, 2022	Salang, Nalang, Kumpur (Siddhalekh)	Transact Walk
2.	June 15- June 25, 2022	Salang and Nalang	Data collection through Questionnaire, FGDs, Interview
3.	October 5- October 13, 2022	Kumpur	Data collection through Questionnaire, FGDs, Interview
4.	November 28, 2022- December 5, 2023	Salang, Nalang, Kumpur	Data collection through Questionnaire, FGDs, Interview
Repeated visit was needed as the roads were not available due to mud pour and had to find suitable timing for visits.			

Table 7 Summary of Visits for data collection

### 5.5 CRA STEPS:

**5.5.1. Identification of Vulnerable Sectors and community elements:** In this step, the vulnerable sectors of Siddhalekh rural municipality are identified. The elements of agriculture are the major

crops that are grown here. The hazards that were identified are rainfall, landslides, and erosion. Besides crops and farming being affected some infrastructures were affected too, even if that was not regular. Table 8 gives a brief summarized view of the identification of vulnerable sectors and community elements that are mentioned above.

<b>Vulnerable sector</b>	<b>Elements</b>	<b>Rainfall</b>	<b>Flood</b>	<b>Erosion</b>	<b>Landslide</b>
<b>Agriculture</b>	Crops:vegetables maize, rice, sesame etc.	Medium	Medium	Medium	High
<b>Infrastructure</b>	Roads, houses, drinking water	Low	Low	Medium	High

*Table 8 Identification of Vulnerable Sectors and community elements*

**5.5.2. Identification of hazard specific risk:** To identify the key branches which are related to the community such as agriculture, housing, livestock, industry, infrastructure and personal property that can be affected by any of the hazards. This will help local people to identify risks that are related to hazard and non-hazard and better understand the hazard specific risk. Information was provided during the discussion session regarding identification of hazard specific risk. The rainfall can be seen as the most common and major hazard in the Rural Municipality. In addition to it, landslides were found to be more prone due to its geography. With the underlying hazards triggering various landslides, the infrastructures; mainly the houses that were already damaged by the 2015 earthquake and roads that were newly constructed were affected.

As per discussions above, following table 9 was constructed.

<b>Hazard</b>	<b>Risk Statement</b>
<b>Rainfall</b>	Rainfall is responsible for landslides of varied frequency and intensity
<b>Geography</b>	High altitude areas more or less contribute in the intensity of landslides
<b>Infrastructure</b>	Landslides can cause damages of different level to houses, roads, schools and other monuments

*Table 9 Identification of hazard specific risk*

**5.5.3. Risk Analysis and evaluation (qualitative):** We analyzed the types of risk, their causes and effects so that a risk reduction option for specific risk and effects can be carried out. The main output would be to identify prioritized risk reduction options against each of the prioritized

unacceptable risks according to its management priority and existing associated actions in place and its success constraints. After visiting the study area and getting information from the locals, it was found that the landslides occur mostly in the newly excavated areas where the hills are being transformed into roads. Due to the high altitude and difficult terrain the roads take a long time to be black pitched which creates hindrances during monsoon and travel becomes harder for villagers resulting shortages in materials such as soap, oil, and some food products. Also, when the roads are not feasible for travel, the pedestrian routes are out of reach as well, as the rivers rise and floods make mobility almost impossible. The schools are closed as the roads are dangerous to walk for the children. Sometimes farmers do not get their market price despite the hurdles and hard work because the vehicles that carry passengers and goods cannot come uphill as the already steep hill tracks are now slippery. It may also lead to lack of services and income irregularity. A quick view of the risk analysis is tabled below (table 10).

<b>Hazards Risk</b>	<b>Non-Hazards Related Risk</b>
<b>Heavy Rainfall causing the landslide</b>	Eroded soils causing clogging in canals
<b>Flooding of rivers due to erosion and heavy rainfall</b>	Waterlogging in other areas due to eroded soils
<b>Displacement of people from their settlement</b>	Irregularity in income generation

*Table 10 Specific Hazards Risk*

#### **5.5.4 Specific Risk Reduction Option:**

This step actually will try to identify the appropriate risk reduction options for the reduction and deletion of risk. The main output would be identified prioritized risk reduction options against each of the prioritized unacceptable risks according to its management priority and existing associated actions in place and its success constraints. The risk identified were landslides, lack of services and loss of property. These risks had potential consequences including loss of lives, missing people, the outbreak of disease as well as the destruction of infrastructures. The consequences were marked with intensities respectively. Further discussions and incorporation of the above table 11 will be continued in chapter 6.

<b>Risk Identifier</b>	<b>Potential Consequences</b>	<b>Consequences</b>	<b>Likelihood</b>	<b>Rating</b>	<b>Acceptability</b>
<b>Landslide</b>	Loss of lives	Major	possible	high	unacceptable
<b>Lack of services</b>	Missing people, the outbreak of disease	Major	possible	high	unacceptable
<b>Loss of property</b>	Destruction of Infrastructures and settlements	major	possible	high	unacceptable

*Table 11 Specific Risk Reduction*

**Why the selection of mentioned data collection tools and their relevance to study in Siddhalekh:**

CRA tools were deemed most appropriate in this research because it entails participation of the community members and more focus on their problems. It is a bottom-up approach and thus can aid the researcher to facilitate a more cohesive picture. The researcher can actively get involved in the day-to-day life of the community people and understand their lifestyle which makes it easier to predict and collect data. Collection of data becomes less of a hassle as the tools and techniques are not haphazardly used but in such a way that the accumulation of data provides information to determine if the acquired data are relevant enough. The chances of error are minimized while the validation of data can be done during data collection itself. The study of outcome provides an insight on how the study is going on and creates a path for further process. The tools and techniques mentioned above were important and feasible for a landslide prone area like Siddhalekh. This process puts the community in the center where community participation is essential, which paves a path for community development as well. During transact walks, Focused Group Discussions (FGDs) and Key Informant Interviews, knowledge sharing takes place. Community people get to know about a lot of things related to disasters, we get to know their localized methods and experiences on disasters. All in all, the tools and techniques' center point are the community people, it helps to keep the community people away from the disaster risk and closer to good development.

## **CHAPTER SIX**

### **FINDINGS AND DISCUSSION**

After conducting various sessions, it was found that Landslide hasn't been the disaster with highest risk, but it was also found that they cannot be neglected either. After the massive earthquake in 2015, the series of landslides have increased despite their low intensity in Siddhalekh area. Besides the tremors of earthquakes, unusual rainfall with varied intensity has been the cause of increased landslide incidents. The landslides are not fatal however; they have been the reason for disrupted daily lives as well as damaged cultivable lands.

The villages started to get roads constructed a decade early without having proper management plants which has created an adverse effect on the surroundings. The naked hills after excavation left untreated have led to unstable slope debris which erodes when there is heavy rainfall. The canals that are constructed either for drainage or irrigation haven't been properly maintained which has caused overflow or blockage. The roads are not made into tarmac, but new routes are constructed every few years which have created more troubles than they have solved. The roads are slippery, making it impossible for four wheelers to go there and walking paths have not been in use mostly since roads were constructed. 60 out of 80 respondents believed that the expansion of roads has become the triggering factors for landslides.



The pictures in following pages show the road and hill conditions after landslide triggered by rainfall during monsoon and late monsoon.



*Figure 8 highway road erosion, (Author, 2022)*

Figure 10 is a major highway that connects Dhading with Kathmandu. This photograph was taken in 2022 September. The highway was in use despite the risk of greater landslide, and nothing was seen to be done to prevent more landslides. However, after the landslide, the Armed Police Force was dispatched to clear the area. Unfortunately, this is a scenario that takes place each monsoon, every year.



*Figure 9 fallen rock after continuous rainfall, (Author, 2022)*

Figure 11 shows a rock that rolled down after continuous rainfall. This picture was taken in Bhedabari, one of the villages in Siddhalekh during the data collection period. This was one of many such incidents that took place due to rainfall. In the picture is a newly extended road, which was then blocked for a few days till the residents of the area cleared it.

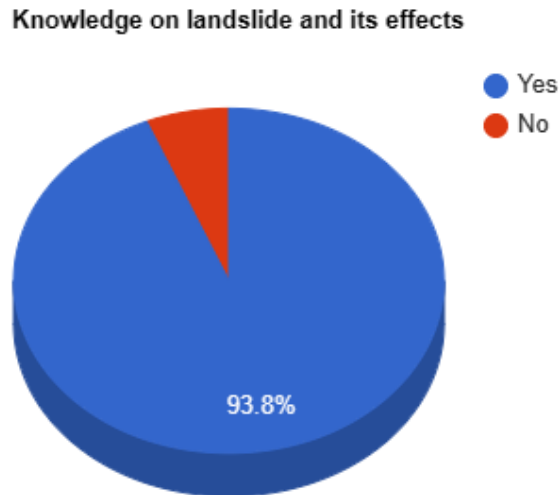


*Figure 10 Debris flow after continuous rainfall, (Author, 2022)*

Figure 12 is a representative picture for almost all roads in the study area. Mud pouring is common after continuous or heavy rainfall. As the roads are constructed by cutting hills and are do spiral rotation around the hill, the debris flows continue over the roads and block the paths. If people or vehicles are moving, there is a high chance that they will be caught in the slide. Road blockages happen to be the most frequent and immediate effect of a landslide that takes place near the roads.

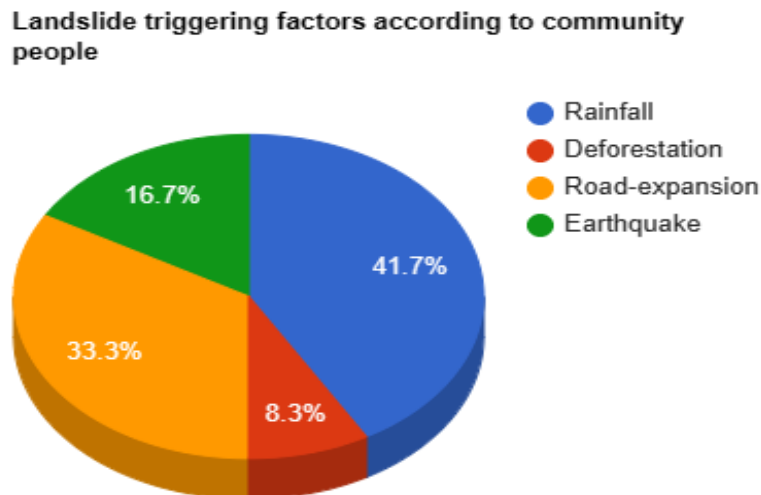
When the respondents were asked if they knew about landslides and its effects, 93.8% of them gave a positive response. On the contrary, 6.3% said they didn't know about the effects of landslides. Generally, landslides meant sliding of cliffs or soil from a slope according to local people. 97% of the times afforestation seemed to be a reduction strategy for landslides. Quoting what the locals said during Focused Group Discussion sessions, "If we plant trees, the roots will help keep the soil and rainfall will not be much of a problem. But the expansion of roads has just not been as helpful as it should be. They (government authorities) keep saying they will complete

the construction of roads by next year and take lands in return to compensation, but we don't know when the next year is coming. We don't know when the roads will finish”.



*Figure 11 Respondent knowledge on landslide and its effects (Author, 2022)*

Being a community that depends largely on agriculture and commodities coming from the city for sustenance, the road blockage caused due to mud pour is responsible for interrupted business and slow economy. However, with increasing urbanization, people have started to generate income through different businesses. The villagers know about the risk of landslides and consequences it can bring very well. Villagers complain that despite the budget being allocated every year for the betterment of transportation infrastructures by the federal government, they are suffering as the roads are not improved, just more excavation to create new routes take place. They are tempted to vote for the people who claim that they will construct new roads and create a hope for easier lives. Around the elections, the political parties do work on transportation and road development which is left incomplete, and the misery continues.



*Figure 12 landslide triggering factors acc. to community people (Author, 2022)*

One of the questions asked in FGDs and interviews was about the triggering factors of landslides in the region. A certain number of people got to experience landslides when they were of young age so they couldn't recall a lot. In the past 10 years as the climate seemed to change, the pattern of rainfall and the duration have been altered as well. Following pie chart shows that the people who believe landslides or mud pour in the reason has been triggered by combination of rainfall and expansion of roads. It was seemed that the rainfall worked as fuel to the fire, when the untamed open slopes with loose soil were washed off by the continuous rainfall which led to slides. Luckily, very less people were harmed. However, cultivable lands, daily activities were hindered which eventually hit the economic activities. Children didn't go to school, as the schools were far from houses and the roads were blocked. In the absence of transportation and fear of mud pours children stayed home.

The respondents were permanent residents of the study area, who have been living in the same area for a few generations. They agreed that the weather patterns have changed and has directly or indirectly affected their cultivation. The rainfall starts either early or late but remains longer which alters the agriculture process. It was also found that heavy and continuous rainfall didn't let crops to grow fully, which eventually affected their economic activities. After the earthquake, small mud pours were found to be common. These mud pours would end up contaminating the water bodies which was also seemed to be common. With increasing technologies and better health care

availabilities, the epidemics are controllable. While discussing about the landslides and its effects, a couple of elders who were above 70 years recalled an incident, which had left the community shook. A landslide that took place in Khursanitar-Bhedabari around 20 years ago was one of the strongest they had experienced. Fortunately, no casualties were recorded. However, the aftermath of the landslide was a big one. Being in a high altitude and remote location, the news of landslide barely got out of the community, except for the regions where they had distant relatives. The landslides blocked their paths, took away cultivable lands and contaminated the water resources the village relied upon. This led to diarrhea breakout and a chaotic situation as there were no roads at all and hours of walking was needed to get to the headquarters. They didn't have medicines that worked fast enough to help them get rid of the diarrhea and the community still had "Vaidya" or traditional ayurvedic practitioners. They were the ones who cleaned up the mud pours, created trails to commute and continue their lives as before. Fast forward to recent days, they are happy that road construction has been making their life easier but lack of funds and delayed projects have made their lives equally disturbed. As soon as the monsoon starts, they have to find alternatives to commute and carry out daily lives just as before. They cannot use the only bus that goes around the hills twice a day. They either wait days till the bus resumes in the bumpy and slippery roads or walk down the trails for hours if they need to go to the "bajar" to buy necessities. In the local level they put big rocks and tree trunks so that the debris do not flow when rainfall is continuous and heavy. They do not go far from their houses but go nearby to get fodder and graze the cattle.

This year (2022), monsoon started early which has induced rainfall and not just Siddhalekh but the whole country has been affected. Inundation, flash floods, mud pour and landslides have been regular on news reports. Within Dhading, there have been casualties as well (Davies, 2022). The major cause of blockage and inundation was seen to be unmanaged sewage and drainage systems. Besides that, the rise of water level in the rivers made it hard for the farmers. The blockage of major highways resulted from landslides caused economic loss as well as human deaths. 11 people were reported to have lost lives in a single day due to landslides and floods all across Nepal according to Radio Nepal (2022).

Through the identification of vulnerable sectors, community elements, and hazard specific risk, rainfall, landslides and erosion along with wildfire were identified as hazards. The elements of agriculture vulnerable to the hazards were the major crops grown along with infrastructures such as huts, roads and drinking water. As an aftermath of earthquake that occurred in 2015, the vulnerable houses and routes were seemed to be affected by rainfall triggered landslides.

Siddhalekh has 79 areas that were affected and is susceptible to future landslides. Being in a hilly region more or less contributes in the intensity of landslides. After visiting the study area and conducting FGDs, and talks while doing transect walks, it was found that the landslides occur mostly in the newly excavated areas in the process of expansion of roads. As the community is in difficult terrain, the excavated roads take time to fully tarmac. The loose soil, sparsely graveled roads become a path for the water to flow washing away the top soil and creating an opening for slides to take place. Part of cliffs, or big stones rolling were found to be common during monsoon whereas dry erosion was seen to happen more during winter and summer seasons.

The villagers suffer most during the monsoon season when rainfall goes on for days making the soil moist and vulnerable to landslides. At times the people face shortages of daily essentials as they have to fetch them from the lower parts of the region where there is access to bigger roads and other facilities. The paths that are either forest route or river banks are not that safe and feasible as the water level rises. The schools are closed as the roads are dangerous to walk for the children. Sometimes farmers do not get their market price despite the hurdles and hard work because the vehicles that carry passengers and goods cannot come uphill as the already steep hill tracks are now slippery. They have to be content on whatever materials they have or use their traditional methods if they cannot go to the market and buy new ones to carry out their farming activities.

For the identified risks in table 11, the following table will show options to reduce the impact in immediate situations as well as long term plans. This stage is mainly reviewed by community people and secondary stakeholders for the compiled output of coping strategies.

Risk	Causes		Possible options	
	Immediate	Ultimate	Immediate	Ultimate
<b>Landslide</b>	Rainfall, slope areas, deforestation	Lack of proper plan and policy	Afforestation, awareness program	Proper planning and budget allocation with the proper policy of risk reduction
<b>Lack of services</b>	The immediate situation of the disaster	Geography, infrastructural condition	Dispatch of humanitarian service	Establishing of health centers, training on first aid after the disaster
<b>Loss of property</b>	Debris flow and erosion, location of housing and settlement	Proper construction and establishment of evacuation areas or temporary housing	Relief aid and assistance	Approval of housing maps according to location, mapping and prohibition of settlement in extreme risk areas

*Table 12 Consensus on Options*

In the table above, the risks followed by causes and the possible option to reduce the risk are discussed. Landslides being the major risk in the Siddhalekh area, the immediate causes of Landslide were rainfall, its slope as well as the deforestation due to urbanization and expansion of roads without proper taming of the hills that were cut. The ultimate cause was found to be lack of proper plan and policy to reduce the risk and control unmanaged urbanization and construction of roads. To tackle the impacts, the immediate option/ solution was afforestation and awareness among the community people to not to agree for road expansion if proper taming of hills would not be done. The ultimate solution was found to be proper policy planning regarding the risk reduction and budget allocation for afforestation, grooming of hills after cutting for road expansions and campaigns.

It was also found that participatory risk assessment can be of great help for the future policy makers as the community people are capable of coping with the disasters. The relief work provided by government has been always slow as per the community people. They believe that the relief arrives faster if it is from a non-governmental body and they have been practicing self-help which has been helping the community and evolving along with the intensity of the disasters.

During the times of earthquake, when the landslides, mudslides and soil erosion were highest, the community people came together and created plans so as to stay safe from possible fatalities. They stayed away from areas that has higher risk of rocks falling and the hills eroding. They let the natural flow irrigate the farm rather than creating any irrigating canals. People's participation has been a great asset in reducing the risk caused by landslides.



Chapter 7 will provide with recommendations and conclusions on the basis of findings and discussions in chapter 6.

### 7.1 RECOMMENDATIONS

If a well-structured Action Plan for Reducing Risk (APRR) is carried out then the development work along with safety of the community and environment may be expected. According to findings, some of the recommended action plans are:

- **Providing training on nursery management:** When the community is hit by heavy rainfall, vegetation that are cultivated or the wild flora are swept away. Even when the local people have been engaged in natural farming for ages, they still are unaware about many vegetations. With collaboration of local NGOs and the provision of training and knowledge on soil conservation, the community people can be educated and thus conserve the environment. In future, they can carry out plantation themselves even if a hired professional is not available. Haphazard plantation is not always capable of reducing the removal of topsoil. The community people can carry out plantation on landslide prone hills with proper safety, if they have enough knowledge on which plants have higher capacity to hold soil. In the Focused Group Discussion (FGD), majority of the villagers mentioned that thinning of forest areas might be the reason for hills not gripping the soils properly, hence they would continue plantation, either through cultivation or trees plantation. While this is an extremely logical, it still needs supervision. The community may not have same type of soil in every region due to varied topography even within the rural municipality. The community people have been farming since ages even before they came in contact with technology so they have more or less idea on types of soil and things related to it. So, proper training and awareness on types of soil and suitable plantation can be certainly helpful on creating a better gripping capacity of soil to reduce landslide and soil erosion of any intensity.
- **Slope upgrade/ Masonry facing:** In the chapter 5, it was found that the untamed slopes were susceptible of landslides. In the above paragraphs, we discussed how development induced landslides are much common in rural areas. Unplanned urbanization and settlement with a hope of better income and better life, the local people are accepting the risk of landslide hazards. An engineering company with trained personnel could be hired

to place barriers on the slopes in order to prevent the slopes that are in the risk of sliding down or carry loose soil that can later flow down in the form of debris. The development works should be continued but with proper managed system for upgrading and restricting the slopes. The community people do not have the capacity to have technical tasks done by themselves, hence the concerned authorities should be working on slope upgrade when and where there are needed. Rather than just cutting the hills and excavating, the process should go side by side in order to mitigate any kind of mishaps caused by landslides. This task has to be done by skilled personnels and experts under concerned authority that is responsible for the contract of road expansions.

Plantation or afforestation always is not possible to reduce landslides. There are areas where vegetation cannot survive hence, the risk of landslides is oddly high. In such areas, contract should be given to the companies to do masonry facing in landslide prone hills where either vegetation cannot survive or is not feasible to have afforestation. Siddhalekh does have such hills, which seem unreachable for people to conduct afforestation. These hills have dry soil, which lets the debris flow easily during monsoon. With reinforced soil retaining slopes, the intensity or frequency of landslides can be reduced. This process can help stabilize the slopes and the community people can continue their daily activities without being concerned. Siddhalekh has such naked hills in almost all the routes, hence the stabilization of slopes through masonry facing can be one of the risk reduction strategies. Masonry facing is to be done under supervision and guidance of skilled personnels. The local government should be responsible for carrying out such activities by hiring skilled manpower including engineers.

- **Early warning system:** The government should keep on checking on the landslide prone areas and determine if the hills are imposing any risk. They can send early warning notices through various telecommunication medias such as TV, radio, cell phones call back tone, SMS service, etc. as well as aware people to stay prepared so that evacuation becomes easier. These days all kinds of people use phones as communication device. According to the recent census, 73% of the population all over the country use mobile phones, either smart phone or just a cellular phone (census, 2023). The government along with provincial and local level authorities can work together to provide awareness messages at certain times of the year. Government of Nepal in collaboration with the telecommunication

companies had started to provide news and awareness messages through call back tone since the covid pandemic and other important events, so this might be of a huge contribution to spread awareness among the target audience.

Hence, with the use of EWS, the people can be at least made aware about the consequences of settling in landslide prone areas, ways to mitigate the risk and distribution of emergency service numbers can help minimize any future hazards. Conducting programs like afforestation, awareness campaign, frequent meetings on educating people about natural disasters, health hazards induced by disasters, after effect of disasters, as well as preventive measure to tackle any disaster situation should be done and EWS should be used efficiently used to reach every corner of the country so that any possible disaster events and damages can be prevented.

## 7.2 CONCLUSION

Road construction and expansion was found to be an essential trigger for landslides. The valleys and settlements in the mountainous ranges were susceptible to property loss as well as human damage. The risk can be reduced given proper study of soil and management of the slopes. Due to absence of proper geological map of the area, the study was based on old maps which were only slightly updated with new points.

While it was good to see the community accepting and moving towards development, it was equally saddening to see cultivable lands destroyed along with the greeneries. It was hard to commute during the monsoon for data collection as the roads were blocked by debris in the highways and gravel roads. Within the communities also, it was hard to carry out day to day activities as the rainfall water dragged soils along with it and paths were slippery. Debris flow from the slopes that were naked after the road expansions and the roads that were just constructed, were found to be the major reasons for landslides. Luckily, human casualties were surprisingly rare; however, the loss of property and cattle were common. The wildfire that takes place in early summers take the credit, more or less, for the increased flow of debris leading to landslides.

The concerned authorities should be attentive to address the problems of landslide and take necessary measure to reduce the risks. Road expansions should be carried out only if they will be asphalted as soon as possible and the hills will not remain untamed. Besides that, it necessary to continue with the afforestation so that rainfall will regulate and the hills will have better water gripping capacity in the soil.

The objective of mitigation is to reduce any kind of future risk caused by landslides and its hazards. Proper use of technology and local resources can be utilized to come up with suitable preventive measures. While there are technologies and machinery that help keep the slopes safe, it is also necessary to maintain the natural scenery along with natural characteristics intact. Siddhalekh more or less is a place tourists visit; hence the area is progressing in developmental works.

Development of infrastructure is a vital component for the economic development of the community and the country too. But, while the development activities are skyrocketing, conservation of nature has remained on the ground. The concerned parties of the Siddhalekh Rural Municipality should be mindful of not harming biodiversity in order to have sustainable

development. Doing so will not only keep the environment safe and development progressive but also contributes to reducing the risks caused by disasters.

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